ON-SITE PRODUCTION OF ELECTRICITY UTILIZING OIL SHALE

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BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to energy production from oil shale and, in particular, to an efficient technique for producing electricity from oil shale utilizing an electrical generator located in close proximity to the site of the oil shale deposit.

2. Discussion of the Related Art

There are very large deposits of oil shale in a number of locations throughout the world, including the United States and Canada. These deposits are said to hold some of the largest oil reserves in the world. The reason that only a very small amount of this oil is currently extracted from these deposits for use in producing energy is the prohibitively high cost associated with the heating, grinding and pulverizing process required to extract the oil from the shale.

A number of methods for recovering oil from oil shale have been proposed. The technology disclosed in U.S. Patent No. 4,265,307 issued May 5, 1981, titled "Shale Oil Recovery" is an example.

As discussed in '307 patent, oil shale is composed of inorganic matter (rock) and organic matter called "kerogen." When oil shale is heated (retorted) at elevated temperatures on the order of 600°F. to 900°F. in the absence of significant oxygen, kerogen is destructively distilled to form a hydrocarbon gas, shale oil and carbon. Shale oil at elevated temperature is in the vapor phase, while the carbon is in the form of coke. Continued heating of shale oil causes decomposition to form more gas and more coke.

As further discussed in the '307 patent, beginning in the 1920's, the first proposals for recovering oil from shale were referred to as "true in situ combustion retorting." As the name suggests, these methods involved the in situ retorting of the oil shale. Heat necessary

for retorting was to be supplied by in situ combustion, combustion being accomplished along a combustion front which moved from one end of the oil shale bed to the other end during the retorting operation.

The true in situ combustion retorting technique was first tried in the 1950's and was attempted a number of times in the 1950's and the 1960's. In carrying out this process, small fissures were introduced into the oil shale bed by hydrofrac techniques prior to retorting in order to expedite the passage of vaporous shale oil out of the bed. Unfortunately, the true in situ combustion retorting technique was not successful.

In the early 1970's, a modification of the true in situ combustion retorting technique was first tried. This technique, referred to as the "modified in situ combustion retorting technique", differs from the true in situ combustion retorting technique in that, prior to retorting, partial mining around the bed is accomplished to provide a greater flow path for the escape of the shale oil. Also prior to retorting, the shale oil bed is broken up or fragmentized (referred as "rubblized') into chunks or pieces. This is usually accomplished by means of explosives. However, the modified in situ combustion retorting technique proved to be ineffective in larger shale oil beds, where yields were only around 30% of theoretical.

In addition to combustion retorting, other techniques have been proposed for the recovery of shale oil from oil shale by the in situ retorting of oil shale. These techniques include the utilization of electrical energy for heating of the oil shale and the utilization of radio frequency energy rather than combustion to furnish the heat necessary for retorting.

While, as indicated above, numerous attempts have been made to effectively capture oil from oil shale beds over the years, no technique has been developed to date that provides a commercially viable production level technique for energy recovery from oil shale.

SUMMARY OF THE INVENTION

The present invention provides systems and methods for generating electricity utilizing oil shale in close proximity to the site of the oil shale deposit and, preferably, utilizing local supplemental energy resources and recycled materials. In accordance with an embodiment of the invention, an electrical power generating facility is located in close proximity to an oil shale deposit. Oil shale removed from the deposit is provided to an on-site burn container. Supplemental heat energy, preferably obtained from local fuel resources

and/or recycled materials, may be provided to the oil shale combustion process. The heat energy generated by the oil shale combustion process is utilized to heat water to generate steam. The steam drives a steam turbine power generator that generates electricity that can be distributed off-site as desired.

The features and advantages of the present invention will be more fully appreciated upon consideration of the following detailed description of the invention and the accompanying drawings that set forth an illustrative embodiment in which the principles of the invention are utilized.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram illustrating a system and method for generating electricity using oil shale in accordance with the present invention.

Fig. 2 is a block diagram illustrating a more detailed embodiment of a system and method for generating electricity using oil shale in accordance with the present invention.

Fig. 3 is a schematic drawing illustrating a dual parabolic solar reflector utilizable in generating electricity using oil shale in accordance with the concepts of the present invention.

Fig. 4 is a schematic drawing illustrating an alternate embodiment of a dual parabolic solar reflector utilizable in accordance with the concepts of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a technique that utilizes oil shale to generate electricity in close proximity to the site of the oil shale deposit.

Fig. 1 shows one embodiment of a general system 100 for generating electricity utilizing oil shale in accordance with the present invention.

The system 100 includes an electrical power generating facility 102 that is located in close proximity to an oil shale deposit 104. It is desirable to locate the electrical generating facility 102 as close to the oil shale deposit 104 as possible, the location of the facility being dependant upon local conditions, including the size of the oil shale deposit itself. The distance from the oil shale deposit to the generating facility should, preferably, be less than 20 miles.

The power generating facility 102 includes a steam turbine power generator 106 of the conventional type utilizable for generating electricity. As indicated in Fig. 1, in accordance with this embodiment of the invention, oil shale 108 in bulk form (i.e., greater than about 1.5 in. diameter) is removed from the oil shale deposit 104 and provided to a conventional burn container 110, such as, for example, a fluidized bed reactor . Those skilled in the art will appreciate that the bulk oil shale can be "rubblized" or "pulverized" (i.e., less than about 1.5 in. diameter) prior to its introduction to the burn container 110. Supplemental fuel 112, which is identified in the Fig. 1 embodiment in the invention as propane, but which preferably is fuel obtained from a source local to the oil shale deposit 104, e.g., ethanol obtained from corn grown in proximity to the oil shale deposit 104, is provided to the burn container 110 such that hydrocarbons contained in the oil shale 108 are combusted to generate thermal energy. The thermal energy generated by the burn container 110 is utilized to heat water 114 to generate steam 116. The steam 116 is provided to the steam turbine power generator 106 to generate electricity 118 that can be distributed as desired utilizing a conventional electricity distribution system or grid.

Fig. 2 shows a more detailed embodiment of the Fig. 1 system 100. As shown in Fig. 2, the recoverable by-products 121 from the burn container 110 include fine potash, including potassium carbonate and potassium hydroxide. It is well known that potassium carbonate is used as a granular powder in making glass, enamel and soaps; potassium hydroxide is a caustic white solid used as a bleach and in making soap, common dyes and alkaline batteries (lye). The need for potassium carbonate and potassium hydroxide could justify the cost of disposing of this burn container by-product. Furthermore, the spent rock 122 resulting from the combustion of the oil shale in the burn container 110 can be returned to the oil shale deposit 104 to minimize the environmental impact of "mining" the bulk oil shale 108.

As further shown in Fig. 2, the steam exhaust heat 124 from the steam turbine power generator 106 and/or exhaust heat 126 from the burn container 110 can be recycled and used to provide preheat energy 128 to the oil shale 108 as it comes into the burner 110. The combination of the recycled preheat energy 128 and the supplemental fuel 112 will result in a temperature that will cause the oil shale 108 entering the burn container 110 to be easily crumpled to a fine powder and facilitate removal of the hydrocarbon in the shale as it is

burned. As mentioned above, if the heat provided from these sources is insufficient, some amount of rubblizing/pulverizing of the bulk oil shale may be required prior to its introduction to the burn container 110 to facilitate more efficient recovery of thermal energy from the oil shale hydrocarbons. Crushing can be powered utilizing the excess steam and/or the electricity generated on-site. Alternatively, some form of radiant energy, e.g. microwaves, could be used to preheat the bulk oil shale, thereby dissolving the kerogen contained in the shale. The supplemental fuel 112 provided to the burn container 110 can be propane or other locally obtained waste material such as for example, wood, sawdust, trash, or manure that can be utilized to generate heat in the burn container 110 or to preheat the oil shale 108 to increase the potash output. As further shown in Fig. 2, the water 114 utilized to generate steam 116 for driving the steam turbine power generator 106 can be preheated utilizing a parabolic solar reflector system 130.

The steam exhaust heat 124 from the steam turbine power generator 106 , which typically will be around 350 degrees F., can also be utilized to assist in the fermentation of locally grown corn to produce ethanol as a supplemental fuel 112 for the burn container 110. Alternatively, the ethanol could be used in dissolving kerogen contained in the oil shale, thereby improving the efficiency of the combustion process in the burn container 110.

Fig. 3 shows an embodiment of a parabolic solar reflector system 130. The center of the parabolic reflector near the axis, which is flatter and more perpendicular to the sun's rays, is used to generate electrical energy utilizing solar panels 131 mounted on the parabolic reflector surface 133. The outer edge reflects solar rays to a black sphere 135 located at a focal point to heat the water ultimately provided as the steam source. As stated above, the exit steam from the steam turbine power generator 106 can be used to preheat the oil shale 108 or can be reused as input to the steam tank.

Fig. 4 provides a more detailed illustration of a preferred embodiment of a parabolic solar reflector system 130. In the Fig. 4 embodiment, the parabolic reflector 130 includes a first parabolic reflecting surface 132 having a first curvature that conforms, as illustrated, to the equation $Y^2=20x$. The parabolic reflector 130 also includes a second parabolic reflecting surface 134 that conforms to a second equation, shown in Fig. 3 as $Y^2=10x$. Both the first parabolic reflecting surface 132 and the second parabolic reflecting surface 134 have the same focal point. A black sphere 136 located at the common focal point of the first parabolic

reflecting surface 132 and the second parabolic reflecting surface 134 receives water 114 from the input source and provides preheated water to the burn container 110 for generation of steam 116. As further shown in Fig. 4, the first parabolic reflecting surface 132 of the parabolic reflector 130 has solar collectors 138 mounted thereon for generating electricity from the solar energy captured by the solar collectors.

It should be understood that various alternatives to the embodiments of the invention described herein might be employed in practicing the invention. It is intended that the following claims define the scope of the invention and that methods and systems within the scope of these claims and their equivalents be covered thereby.